Trends in Federal Information Technology R&D

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2003 Fall National SBIR/STTR Conference
October 29, 2003

Federal role in networking and information Technology R&D

- Federally-sponsored research builds the technology base on which the information technology industry has grown
- Federal government funds basic research not funded by industry
  - High risk, innovative ideas whose practical benefits may take years to demonstrate
- Networking and Information Technology R&D program (NITRD) helps focus interagency IT R&D:
  - Identify common research needs
  - Plan inter-agency research programs
  - Coordinate and collaborate on research announcements and funding
  - Review research results and adjust accordingly
- Estimated FY 2004 NITRD Budget is $2.15 billion
- NITRD program doesn't directly manage IT SBIR, but agency program managers are involved
- National Coordination Office for IT R&D (NCO) coordinates planning, budget, and assessment activities for the NITRD Program
- NCO Director reports to the Director of the White House Office of Science Technology Policy (OSTP) and co-chairs the Interagency Working Group for IT R&D

Participating Agencies and Departments

- Department of Defense
  - Defense Advanced Research Projects Agency (DARPA)
  - Defense Information Systems Agency (DISA)
  - National Security Agency (NSA)
  - Office of the Director of Defense Research and Engineering (ODDR&E)
- Department of Energy
  - Office of Science (DOE/SC)
  - National Nuclear Security Administration (DOE/NNSA)
- Department of Health and Human Services
  - National Institutes of Health (NIH)
  - Agency for Health Research and Quality (AHRQ)
- Department of Commerce
  - National Institute of Standards and Technology (NIST)
  - National Oceanic and Atmospheric Administration (NOAA)
- National Science Foundation (NSF)
- National Aeronautics and Space Administration (NASA)
- Environmental Protection Agency (EPA)
- Observer: Federal Aviation Administration (FAA)

NITRD Program Coordination

WHITE HOUSE

Executive Office of the President
Office of Science and Technology Policy

National Science and Technology Council

President's Information Technology Advisory Committee (PITAC)

U.S. Congress

NITRD Authorization and Appropriations Legislation

National Coordination Office (NCO) for Information Technology Research and Development

Interagency Working Group (IWG) on Information Technology R&D

Participating Agencies: AHRQ, DARPA, DOE/NNSA, DOE/SC, EPA, NASA, NIH, NIST, NOAA, NSA, NSF, ODDR&E

- **High End Computing Coordinating Group (HEC)**
- **Large Scale Networking Coordinating Group (LSN)**
- **High Confidence Software and Systems Coordinating Group (HCSS)**
- **Human Computer Interaction & Information Management Coordinating Group (HCI & IM)**
- **Software Design and Productivity Coordinating Group (SDP)**
- **Social, Economic and Workforce Implications of IT and IT Workforce Development Coordinating Group (SEW)**

Bill Joy (SUN Microsystems Founder):

"People still don't recognize the scope of what we have to do. You can't simply write a new, multimillion-line program in C and expect it to be reliable unless you're willing to work on it for 20 years. It takes such a long time because that language doesn't support the easy detection of the kinds of flaws most viruses exploit to bring down systems. Instead, you need to use a programming language with solid rules so that you can have the software equivalent of chemistry: the predictable interaction of code as it runs. But on the network, where part of the software works here and part of it works there, programs also behave in emergent ways that are more biological and difficult to predict. So until you have a science of doing distributed computing, software developers will continue to just throw stuff out there. That's why the Net is not going to be secure.

"Also, distributed software systems have to be a lot simpler than they are now for us to have any hope of understanding even the mechanistic consequences, much less the nonlinear, biological consequences."

Fortune Magazine, October 13, 2003

General Trends in IT R&D

- Dealing with complexity and large numbers
- Improving reliability and usability
- Improving security: trust, confidentiality, privacy
- Improving human-computer interactions
- Improving the ability of systems to reason and augment human capabilities
- Understanding what systems are doing – metrics
- Cooperation across organizations, disciplines, countries
- Multidisciplinary approaches
- Moving to new technologies – optical networking, wireless, quantum computing, nano-technologies
- Growth of computing in bio-medicine

High End Computing

- **www.itrd.gov/hecrtf-outreach/index.html**
- **Hardware technology areas**
  - Better microarchitecture designs
  - Addressing “memory wall”
  - High bandwidth, low latency interconnect systems
  - Reducing power, cooling, and volume requirements
  - Improved I/O and storage
- **Software technology areas**
  - Operating systems
  - Languages, compilers, and libraries
  - Software tools and development environments
  - Algorithms
- **System technology areas**
  - Architecture
  - System modeling and perforanalysis
  - Reliability, availability , serviceability , and security
  - Programming models

Large Scale Networking

- http://www.itrd.gov/iwg/lsn/lsn-workshop-12mar01/index.html
- **Research needs include:**
  - Adaptive, dynamic and smart networking
  - Measurement, modeling, simulation, and scalability
  - Trust: Security, privacy, and reliability
  - Networking application
  - Networking middleware
  - Testbeds
  - Collaboration environments
  - Networking fundamentals
  - Revolutionary research

Human-Computer Interaction and Information Management

- http://www.itrd.gov/pubs/hci-im_research_needs_final.pdf
- **Research needs areas include:**
  - Information creation, organization, access, and use
  - Managing information as an asset
  - Human-computer interaction and interaction devices
  - Evaluation methods and metrics

Software Design and Productivity

- **http://www.itrd.gov/pubs/sdp_wrkshp_final.pdf**
- **Research needs areas include:**
  - Improved ways to specify and manage system requirements
  - Better software development and management environments
  - Sophisticated testbeds that can simulate realistic operational situations

High Confidence Software and Systems

- **http://www.itrd.gov/pubs/hcss-research.pdf**
- **Research goals include:**
  - Provide a sound theoretical, scientific, and technological basis for assured construction of safe, secure systems
  - Develop hardware, software, and system engineering tools that incorporate
  - Reduce the effort, time, and cost of assurance and quality certification processes
  - Provide a technology base of public domain, advanced-prototype implementations of high-confidence technologies to enable rapid adoption
  - Provide measures of results

Illustrative IT Hard Problems (1)

- **Algorithms and Applications**
  - Modeling and simulation
- **Complex Heterogeneous Systems**
  - Adaptive scheduling and control
  - Complex systems/emergent behavior
  - Control of physical systems including scientific experiments and SCADA systems
  - Distributed decision making
  - Embedded systems including actuators, sensors, and MEMS
  - Robotics
- **Hardware Technologies**
  - Biological technologies
  - Nanoscale technologies
  - New mass storage technologies
  - Quantum technologies

Illustrative IT Hard Problems (2)

- **High Confidence IT**
  - Data and information security
  - High confidence middleware
  - High confidence open source
  - Reliability
  - Safety
  - Security including authorization, authentication, biometrics, certification, encryption, interfaces, and protocols
  - Software assurance
- **High End Computing Systems**
  - Grid computing
  - High end computing architectures, systems software, and applications software
  - Use of biological, nanoscale, and quantum technologies in high end computing systems

Illustrative IT Hard Problems (3)

- **Human Augmentation IT**
  - Augmented cognition and augmented reality
  - Collaboration technologies
  - Visualization
- **Information Management**
  - Asynchronous collection and processing of independent data streams
  - Coherent databases developed from distributed data of varying quality
  - Data and information management
  - Data mining and data warehousing
  - Data representation
  - Distributed processing and storage
  - Preservation

Illustrative IT Hard Problems (4)

- **Intelligent Systems**
  - Cognitive systems
  - Context-aware computing and autonomic networks to add more intelligence to IT systems
  - Human language technology
  - Knowledge discovery, representation, and integration
- **IT System Design**
  - Architecture
  - Graceful evolution
  - Hardware/software co-design
  - Interoperability
  - Preservation
- **IT Usability**
  - Human/computer interaction including user interfaces
  - Universal accessibility

Illustrative IT Hard Problems (5)

- **IT Workforce**
  - Advanced IT for non-IT specialists
  - Interdisciplinary interaction
  - IT workforce issues
- **Management of IT**
  - Intellectual property issues
  - Open source issues
  - Standards
  - Technology transfer
- **Networks**
  - Grid
  - Mobility
  - Network middleware
  - Networking management, reliability, and scalability
  - Sensor networks

Illustrative IT Hard Problems (6)

- **Software Technologies**
  - Programming environments
  - Programming languages
  - Software requirements engineering, software, development methods and tools, and software engineering
  - Systems software and middleware

Functional INFOSEC hard problems (1999 edition)

www.infosec-research.org

- Intrusion and Misuse Detection
- Intrusion and Misuse Response
- Security of Foreign and Mobile Code
- Controlled Sharing of Sensitive Information
- Application Security
- Denial of Service
- Communications Security
- Security Management Infrastructure
- Information Security for Mobile Warfare

INFOSEC hard problems for design and development of INFOSEC systems (1999 edition)

www.infosec-research.org

- Secure System Composition
- High Assurance Development
- Metrics for Security

For Further Information

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www.itrd.gov